continuous, though they are sometimes as bright as true magnetic auroras which show the citron line.

The average number of nights on which I have seen these irregular auroras in the past 28 years, chiefly at Sunderland, is 1·9 per annum; and, if doubtful cases are included, 2·7. They agree with magnetic auroras in so far as they show some tendency to an eleven-year periodicity, being most frequent about 2 years after the sun-spot maximum, and least so about 5 years later.

T. W. BACKHOUSE.

Sunderland, January 15.

MR. STROMEYER's letter in NATURE of the 9th inst. (p. 225) reminds me of a magnificent display that I once saw of luminous white clouds, transparent to the stars, which shone brightly through them. These clouds were extended like ribbons from north to south across the sky, in a way not uncommon with true clouds. I thought, and still think, that they were an aurora. May not those described by Mr. Stromeyer have been the same?

Belfast, January 15. JOSEPH JOHN MURPHY.

The Meteorite of Migheï.

WITH reference to the interesting meteorite of Migheï, examined by M. Stanislas Meunier, I have not observed, in any of the notices I have seen, any statement as to whether the organic matter exhibited any traces of an organized structure. I would suggest that, if it has not already been done, it should be carefully examined to see if the carbonaceous matter shows any such traces.

J. RUTHERFORD HILL.

January 11.

Achlya.

I SHALL be very grateful to any of your readers who can send me specimens of *Achlya* with the sexual reproduction, which I cannot at present obtain in my cultures. The culture should be dropped bodily into a cold saturated solution of corrosive sublimate, in a wide-mouthed corked bottle, and this filled up with the liquid to the cork before posting.

MARCUS M. HARTOG.

5 Roseneath Villas, Cork, January 6.

The Parallelogram of Forces.

WHAT is the force of the word "rigid," introduced into the statement and proof of the parallelogram of forces and other theorems in Statics, as quoted by Mr. W. E. Johnson from the ordinary text-books?

The word "rigid" requires definition; it describes a state of things which is not met with in Nature; and it is redundant and limiting; because the conditions of equilibrium of a body are the same, whether elastic to an appreciable extent, or to such an inappreciable extent that the word "rigid" may be applied to it.

Better omit the word "rigid" altogether.

A. G. GREENHILL.

Foot-Pounds.

IN the statics and dynamics paper set in the last Woolwich entrance examination, candidates are asked to determine the magnitude of a moment of a force in *foot-pounds*. Surely it is unfortunate to introduce this term in such a sense. One foot-pound is a unit of work, and though its dimensions (ML^2T^{-2}) are the same as that of a unit of a moment of a force, the two conceptions are perfectly distinct, and the introduction of a foot-pound as a unit of a moment of a force is likely to cause confusion, especially in the minds of beginners.

A. S. E.

Chiff-Chaff singing in September.

IN a review of certain recent ornithological works, in one of your latest issues, doubt seems to be thrown on the fact of the chiff-chaff singing late in September.

I believe it is not an unusual occurrence. It always nests in my garden, and this year, as I see by a note made at the time, it sang on the 20th, 21st, and 22nd of that month. We had a slight frost on the 21st.

F. M. BURTON.

Highfield, Gainsborough, January 6.

EAST AFRICA AND ITS BIG GAME.[1]

FOR sporting purposes Cape Colony and the adjoining districts are long ago "used up," and the hunter who would fain see "big game" must follow Mr. Selous into Matabelé-Land and Mashoona-Land, if he does not find it better to cross the Zambesi. Even here, some of the largest animals are already exterminated. The redoubted hunter whose name we have just mentioned has not met with a White Rhinoceros during the past four seasons, and his "bag" of ivory shows a yearly diminution. So much for the south of the Dark Continent. The northern entrance to the great Interior, which afforded Sir Samuel Baker and those who followed him such splendid sport on the Atbara and Settite, has been closed up by the Mahdists, and until we have made up our minds to "clear out Khartoum," no European can hope to penetrate in this direction. There remains, therefore, only the eastern coast as a mode of access to the wild interior of game-tenanted Æthiopia, the west coast being practically closed by swamps and fevers.

On the eastern coast of Africa, however, immediately under the equator, a splendid stretch of high-lying land, full of big game, and easy of access, is still open to the enterprising sportsman. First made known to us by the German missionaries Rebmann and Krapf, the "Kilimanjaro District," as it is now usually called, was subsequently opened to us by Von der Decken, New, and Hildebrandt. To these explorers succeeded Mr. Joseph Thomson on his route to Masai-Land, and Mr. H. H. Johnston on his expedition up the Kilimanjaro Mountain, to which Dr. Hans Meyer and other more recent travellers have also devoted their special attention. Access to this sportsman's paradise is rendered easy by the port of Mombas, now under the benign sway of the British Imperial East African Company, and connected with Aden by a regular line of steamboats. Here, in the autumn of 1886, having made the necessary preparations at Zanzibar, the author of the present volume, with his brother sportsmen Sir Robert Harvey and Mr. H. C. V. Hunter, assembled their caravan. Their plan was to reach as quickly as possible the forest of Taveta, distant about 250 miles from the coast and within ten miles of the base of Kilimanjaro, and having established their head-quarters in this favoured spot, to work thence the surrounding plains and open country. Mr. C. B. Harvey, the brother of Sir Robert, was to join them when his leave commenced, a month later.

How well this programme was carried out the entertaining pages of Sir John Willoughby's narrative fully explain to us, while the map at the commencement clearly shows the route and the nature of the different districts traversed, as they appeared to the eyes of the enthusiastic sportsmen. Much time and trouble was saved to the expedition by the selection of a Maltese named Martin as "chief of the staff." Martin had accompanied Mr. Thomson during his adventurous journey into Masai-Land, and was, moreover, the owner of a "freehold building-site" at Taveta. Hereon was a house and a range of huts, forming three sides of a large square, while the fourth was bounded by a sparkling rivulet well stocked with fish. Such a haven of refuge, protected, as it was, by a thorn-hedge with a strong gateway, and situated in the immediate vicinity of a good game-country at an elevation of 2400 feet above the sea-level, seemed little less than a Paradise to our travellers, who arrived here on December 26, about sixteen days after leaving Mombas. Into their various excursions from this convenient centre we need not closely follow them. Suffice it to say that their routes were mostly to the west of Taveta, amongst the numerous streams that drain the southern slopes of Kilimanjaro and unite to form the Ruvu River, which enters the sea at Pangani, and to the east of the great mountain on the head waters of the Tzavo. These various hunting expeditions occupied the time until April 21, when a safe return was effected to Mombas, and thence to Europe.

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[1] "East Africa and its Big Game, the Narrative of a Sporting Trip from Zanzibar to the Borders of the Masai." By Captain Sir John C. Willoughby, Bart., Royal Horse Guards. With Postscript by Sir Robert G. Harvey, Bart. Illustrated by G. D. Giles and Mrs. Gordon Blake; those of the latter from photographs taken by the Author. (London: Longmans, 1889.)

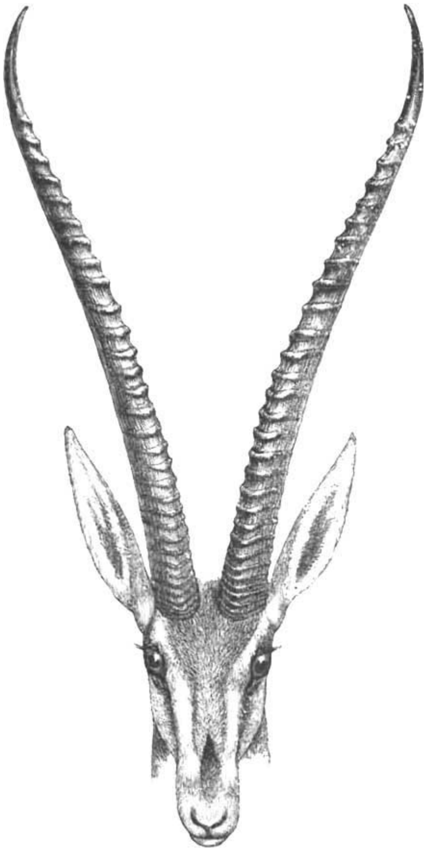

Fig. 1.—Head of Grant's Gazelle.

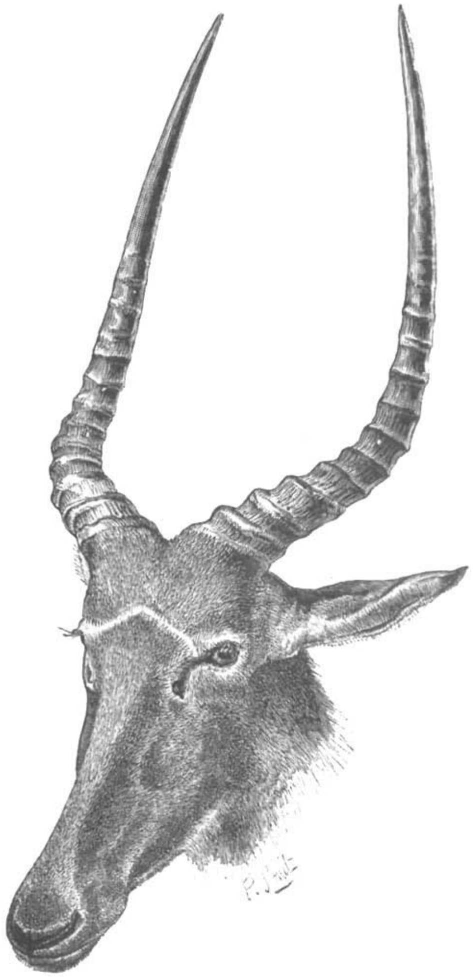

Fig. 2.—Head of Hunter's Antelope.

The list of larger game-animals killed by the party during their four months shows a goodly total of 330 head, although we are assured by Sir John Willoughby that no useless slaughter was perpetrated during the expedition, and that no animal was killed unless required for a specimen, or for food by the hunters and their native companions. In the list of these 330 animals, we find 21 Buffaloes, 66 Rhinoceroses, 2 Elephants, 4 Hippopotamuses, 4 Zebras, and 211 Antelopes of different species. But a much more attractive list to the naturalist will be found in the appendix "on the fauna of the plains round Kilimanjaro," compiled by Mr. Hunter. So little is yet known of the larger mammals of this fine country, except from fragmentary notices, that Mr. Hunter's notes, brief as they are, form a not unimportant contribution to zoological science. Lions, Elephants, Hippopotamuses, and Giraffes are prevalent alike in every part of Wild Africa, but the splendid Bovine animals called Antelopes vary very materially in the different districts. In the Kilimanjaro country, sixteen Antelopes are recorded as having been met with, and amongst them are some of the finest and largest of the whole group. The Eland (*Oreas canna*) is "rather local," but there "are a fair number to the south of the mountain." The Eland found here belongs to the variety called Livingstone's Eland, first met with by that great explorer on the Zambesi. "Both males and females are all more or less striped." The Larger Kudu (*Strepsiceros kudu*) was "only seen on two or three occasions on the Useri River"; the Lesser Kudu (*S. imberbis*) is found "in the bush around Taveta," and in several other localities. Two examples of this until lately little-known Antelope from this district are now living in the Zoological Society's Gardens. The Beisa (*Oryx beisa*) is "plentiful on the plains and in thin thorny bush"; the Coke's Hartebeest (*Alcelaphus cokii*) is "quite the most common Antelope on the plains, being found everywhere in immense herds"; while the Brindled Gnu (*Connochœtes gnu*), the Mpallah (*Æpyceros melampus*), and the Waterbuck (*Cobus ellipsiprymnus*) are, according to Mr. Hunter, abundant in appropriate localities. We suspect, however, that Mr. Hunter's so-called "Waterbuck" is the Sing-sing (*Cobus sing-sing*), of which some fine heads were procured by Mr. Holmwood, lately H.B.M. Consul at Zanzibar, during an excursion to the Tavita district. Of the beautiful tribe of Gazelles, three well-marked species, all recently discovered and appropriately named after distinguished African travellers, tenant the plains of Kilimanjaro. These are the Grant's Gazelle (*Gazella granti*), the Thomson's Gazelle (*G. thomsoni*), and the Waller's Gazelle (*G. walleri*). Grant's Gazelle is "common everywhere on the open plains." Its fine lyre-shaped horns attain a larger development than in perhaps any other species of the genus. Their elegant shape and prominent outlines will be seen by the accompanying figure from the Proceedings of the Zoological Society. Thomson's Gazelle was found in large numbers in the plains of the Masai country to the south-west of the mountain. Waller's Gazelle was "very rare near Kilimanjaro," but subsequently found to be numerous up the Tana River. One was killed near Lake Jipé. But the great prize among the Antelopes was met with by Sir Robert Harvey and his companions Messrs. Greenfield and Hunter, during a subsequent expedition to Eastern Africa. In the course of this journey they ascended the River Tana, which forms the northern boundary of the dominions of the British Imperial East African Company. Here, on the northern bank, they came across specimens of an entirely new Antelope, "of a bright red colour, in some respects resembling a Hartebeest, especially in regard to the length of its head, and of about the same size, but hardly so high at the withers." This

Antelope has been since named Hunter's Antelope (*Damalis hunteri*) by Mr. Sclater (see Proc. Zool. Soc., 1879, p. 372, Pl. xlii.), and mounted specimens of it may be seen in the Mammal Gallery of the Natural History Museum at South Kensington.

It must not, however, be supposed that the rich mammal-fauna of the Kilimanjarŏ district has been yet entirely exhausted. We read, in Sir John Willoughby's narrative, of a Duiker Antelope (*Cephalophus*), of a dark red colour, found on the mountain, of which a specimen was obtained by an American traveller, Dr. Abbott, but not by the British sportsmen. On the same mountain, at an elevation of about 9000 feet, Dr. Abbott also secured an example of an "extraordinary animal" like a Serow (*i.e. Capricornis bubalina* of the Himalayas), but "darker in colour and shorter on the legs." There is therefore ample room for future discoveries, both in this and in other branches of natural history. The plateau surrounding Mount Kenia, which has yet to be explored scientifically, would doubtless supply many other novelties. In short, at the present time we know of no other field for zoological discovery so promising and so easily accessible as the slice of Eastern Africa recently assigned to Sir William Mackinnon and his associates of the B.I.E.A. Company, to which the author of the present volume has given us such a useful and agreeable introduction.

THE CORAL REEFS OF THE JAVA SEA AND ITS VICINITY.[1]

SINCE comparatively few of the naturalists who have sojourned in the Indian Archipelago have paid special attention to the coral reefs of that region, it becomes a cause of satisfaction that Dr. C. Ph. Sluiter, of Batavia, who has long been engaged in studying the marine fauna of his neighbourhood, has taken up the subject in earnest. In a paper on the origin of the coral reefs of the Java Sea, and of Brandewijns Bay on the west coast of Sumatra, and on the new coral formations of Krakatão, Dr. Sluiter gives the results of his recent preliminary investigations.[2] This paper is excellent in method, and the results of the highest importance.

In the western half of Batavia Bay, where the depth varies from 5–12 fathoms, there are numerous coral reefs which occur in all stages of growth from the incipient reef to the coral island begirt with a barrier-reef. Being curious to learn how the corals first began to grow on the muddy bottom of this bay, the author of this paper soon found an explanation in the fact that the stones and fragments of sunken Krakatão pumice, which lay in places on the mud, were covered with living corals. Hence he concluded that in those favourable circumstances where several of the stones and pumice fragments lay close together we might have the beginning of a reef. A singular feature in the growth of these reefs then attracted his attention. Some fourteen years ago, an artesian boring was made in the small coral island of Onrust in Batavia Bay, when an accumulation, 20 metres thick, of coral *débris*, shells, and clay, was found to pass downward into a firmer clay. The depth of the sea around is only 11 metres, and after allowing about 2 metres for the height of the island, Dr. Sluiter infers that the coral fragments have sunk down 7 metres into the mud or clay of the sea-bottom.

To support this view, the author gives a section of the shore-reef of Brandewijns Bay, on the west coast of Sumatra, the section being constructed from data supplied by fifteen borings, none deeper than 24 metres, the reef there being rather under 300 metres wide. As is there shown, the volcanic formations of the steep coast-border descend at a precipitous angle under the sea, so that they do not form a foundation for the shore-reef. This reef, the thickness of which varies greatly, being in some places as much as 11 metres and in others only half that amount, lies on "a substratum of clay or mud mixed with coral *débris*, and forming a bed ranging from 2 to 7 metres in thickness." This substratum of clay and coral passes down into a clay or mud, formed from the decomposed andesitic rocks of the district, which may be firm in some places and soft in others. The next point brought out in the section is that the substratum of clay and coral *débris* is thickest and deepest where the underlying clay is soft, and thinnest and nearest to the surface when the clay is firm or is mixed with sand. From these and allied considerations, Dr. Sluiter passes on to the conclusion that the same process has taken place here which occurs in the construction of dams and piers on a yielding bottom, a large amount of coral materials having been sunk in the mud, whilst the reef, by its own weight, has prepared its own foundation.

Having been familiar with the appearance of Krakatão before the great eruption of 1883, Dr. Sluiter observed some interesting changes in connection with the shore-reefs of this island when he revisited it in 1888 and 1889. The pumice and ashes at the time of the outbreak, according to the account of Dr. Verbeek, the historian of the eruption, destroyed all life in the sea around, making the sea-bottom a lifeless waste; and under an accumulation, 20 metres thick, of these materials lies the old shore-reef. In 1888 and 1889 the old condition of things was beginning to re-assert itself. In one place a young shore-reef, composed mostly of madrepores, had attained a breadth of a metre, and living corals were brought up in abundance by the dredge, attached to sunken pumice. Amongst the measurements of coral growth given by the author are those relating to specimens of *Madrepora nobilis*, Dana, which had attained a length of from 2 to 2½ decimetres in a period that could not have exceeded five or six years, and was probably much less. Specimens of *Porites mucronata*, Dana, had also in the same period grown to a length of 1 decimetre.

After referring briefly to the interesting Thousand Islands, a linear group of small coral islands near Batavia, many of which, in the southern part, affect the atoll form, Dr. Sluiter sums up the results of his observations. A coral reef in the Java Sea *commences its growth on a muddy bottom* in the form of a colony of corals growing on the *stones* and *sunken pumice* that there lie. As it increases in extent and height, it secures its own foundation by its weight, a large amount of coral materials sinking into the mud to a depth of seven or less metres. In its upward growth it presents a level top, and displays no hollow or basin, a uniformity which it preserves until a foot from the surface, when it dies in the centre, and the agencies dwelt upon by Murray and Agassiz then co-operate in forming an atoll or a barrier-reef. Because the small coral reefs (500 metres wide) of the Java Sea grow up uniformly until near the surface, Dr. Sluiter places himself in partial antagonism to a portion of Murray's theory. In this, however, he has missed the point of the new view, according to which such small reefs would either have no lagoon or else possess a very shallow one. With this correction, his partial confirmation of Murray's theory becomes more complete.

We hope that, with the great facilities at his disposal, Dr. Sluiter will make an exhaustive examination of the Thousand Islands, the varied and unusual conditions of their growth rendering them particularly important as a field for thoroughly investigating the problem.

H. B. GUPPY.

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[1] "Einiges über die Entstehung der Korallenriffe in der Javasee und Branntweinsbai, und über neue Korallenbildung bei Krakatau." Von Dr. C. Ph. Sluiter. (Batavia en Noordwijk: Ernst and Co., 1889.)

[2] *Natuurkundig Tijdschrift voor Nederlandsch Indië*, Band xlix.